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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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BLAKELY SOKOLOFF TAYLOR & ZAFMAN
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CA 90025-1030

EXAMINER	
MAGEE, THOMAS J	
ART UNIT	PAPER NUMBER
2811	

DATE MAILED: 07/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/820,079	KLOSTER ET AL.	
	Examiner	Art Unit	
	Thomas J. Magee	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 April 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-10,12-14,16-20 and 28-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-10,12-14,16-20 and 28-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Cancellations

1. Applicant's cancellation of Claims 35 – 38 in Letter of 11 April 2005 is acknowledged.

Claim Rejections – 35 U.S.C. 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 5 – 7, 29 – 33, 37, and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (US 6,211,061 B1) in view of Fink et al. ("Standard Handbook for Electrical Engr." McGraw-Hill, New York (1968)).

4. Regarding Claim 1, Chen et al. disclose (Col. 5, line 65 through Col. 6, line 22) a structure on a substrate comprising a diffusion barrier layer (24) (Figures 4 and 6B) having a first dielectric constant (7.5, silicon nitride), and a thickness in the range, 300 to 500 Angstroms, with a layer (30) used as a layer used as an etch stop layer (See Figure 4) above and on the diffusion barrier layer with a second thickness and a dielectric constant < 3.0 and an interlayer dielectric (34) of thickness, 3000 Angstroms, with a dielectric constant of 3.9 (silicon dioxide).

Additionally, Chen et al. do not disclose the effective dielectric constant of the structure.

However, the determination of effective dielectric constant is calculable from extremely simple equations notoriously well known to those of average skill in the art using elementary Physics and Electrical Engineering texts and handbooks (See for example, "Standard Handbook for Electrical Engr."). Capacitance for capacitors in series (stack of dielectric layers) is: 1/C(total) = 1/C(1) + 1/C(2) + ... And in general, C = kA/d, where k is the dielectric constant, A is area, and d is thickness. The effective dielectric constant is then approximated by: k(eff) = d(total) C(total)/A, where 1/C(total) = (1/A)[d1/k1 + ...] , whereby k (eff) = d(total)/ [(d1/k1) + (d2/k2) + (d3/k3)], where d1,k1..... refer to layer 1, etc. Substituting values disclosed by Chen et al. in the equation, the effective dielectric constant is less than three, and is therefore, an inherent property of the structure.

5. Regarding Claims 5 and 6, Chen et al. disclose (Col. 6, lines 4 – 12) that the barrier layer is inorganic (silicon nitride) and the etch stop layer is organic (FLARE, SILK).

6. Regarding Claim 7, Chen et al. disclose that an electrically conductive trace is present in the substrate (Col. 5, lines 65 – 67) (20, Figure 6B) and a contact (Col. 8, lines 1 – 2) present in a recess (45) that extends through the ILD, etch stop, and barrier layers making electrical connection to the trace.

7. Regarding Claim 29, Chen et al. disclose that the (third) thickness of the ILD layer (34) is 3000 Angstroms (Col. 6, lines 14 – 17) and that the second layer thickness is 1600 Angstroms, such that the third thickness is greater than the second (3000 > 1600 A).

8. Regarding Claim 30, Chen et al disclose that the (third) thickness of the ILD layer (34) is 3000 Angstroms (Col. 6, lines 14 – 17). Chen et al. do not disclose that the third thickness is at least 5 times as thick as the second thickness. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to perform a series of experiments to obtain a third layer thickness in the recited range of the instant application to reduce parasitic capacitance.

9. Regarding Claim 31, Chen et al. disclose that the second thickness is about 5000 Angstroms (Col. 6, lines 10 – 11) and the first thickness is about 500 Angstroms, such that the second thickness is greater than the first thickness (5000 > 500 A).

10. Regarding Claim 32, Chen et al. disclose that the second thickness (5000 Angstroms) is at least 10 times as thick as the first thickness (500 Angstroms).

11. Regarding Claim 33, Chen et al. disclose that the ILD layer has a third thickness and as discussed for Claims 32 and 38, that the second thickness (5000 Angstroms) is at least 10 times as thick as the first thickness (500 Angstroms). Chen et al. do not disclose that the third thickness is at least 5 times as thick as the second thickness. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to perform a series of experiments to obtain a third layer thickness in the recited range of the instant application to reduce parasitic capacitance.

12. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. in view of Fink et al., as applied to Claims 1, 5 – 7, and 29 – 33, and further in view of Wang et al. (US 6,291,887 B1).

Chen et al. do not disclose an organic diffusion barrier layer and an inorganic etch stop layer. However, Wang et al. disclose (Col.8, lines 16 – 21, lines 44 – 46) that the first (diffusion barrier) layer (14) (Col. 5, lines 20 – 24) is a arylene ether polymer (FLARE) (organic) and the etch stop layer (16) is nitride (inorganic) (Col. 5, lines 36 – 38). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Wang et al. with Chen et al. to obtain a dielectric layer stack with low "effective" dielectric constant.

13. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (US 6,211,061 B1) in view of Fink et al., as applied to Claims 1, 5 – 7, and 29 – 33, and further in view of Dubin (US 6,249,055 B1).

14. Regarding Claim 8, Chen et al. do not disclose a "single" damascene structure for the contact, but do disclose a dual (or T-shaped) damascene structure. The difference between a single and a dual damascene structure involves only a change in shape and a continuous etch through the layers for the single, whereas the dual requires two etch steps, as is notoriously well known in the art. Dubin, for example, discloses (Figure 1) (Col. 6, lines 19 31) that the single and dual damascene structures are formed in a similar sequence, the latter involving only a second etch step. Hence, it would have been obvious to one of ordinary skill in the art at the time of the invention to alter the "shape" of the contact to

produce a single damascene structure and to combine Chen et al. with Dubin to obtain a compact connect metallization structure.

15. Claims 12 – 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Uglow et al., as applied to Claims 9 and 10, and further. in view of Fink et al.

Chen et al. do not disclose effective dielectric constants for the ILD, etch stop, and diffusion barrier layer "stacks". As discussed for Claim 1, the effective dielectric constant is approximated (Fink et al.) by the equation: d(total)/ [(d1/k1) + (d2/k2) + (d3/k3)] , where d1,k1, ... refer to thickness and known dielectric constants of layer 1, etc. Uglow et al. do not explicitly disclose the thickness of the diffusion barrier layer, d1. However, Uglow et al. do disclose that the total thickness of the dielectric layers is about 10,000 Angstroms (Col. 6, lines 62 – 63). Since the thickness of the second (104) layer is 4500 Angstroms (Col. 4, line 50) and the thickness of the third (106) layer is 5000 Angstroms, the thickness of the first (barrier) layer is about 500 Angstroms. I

Using the values of thickness over the range disclosed by Uglow et al. and known dielectric constants, approximate range of effective dielectric constants is calculated using Fink et al. to values in the range, 2 to 3.Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to combine Fink et al. with Uglow et al. to obtain low effective k values for the "stack" combination.

16. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to Claims 16 – 18, and further in view of Wolf.("Silicon Processing for the VLSI Era, Vol. 4 – Deep Submicron Process Technology," Lattice Press, Sunset Beach, CA (2002), p.641)

Chen et al. do not explicitly disclose a dielectric constant for the etch stop layer. Wolf (Figure 14-2) discloses that SILK (one of the materials disclosed by Chen et al.) has a dielectric constant less than about 2.8. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Chen et al. and Wolf to obtain low effective k values for the "stack" combination.

17. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al., as applied to Claims 16 – 18, and further in view of Bains ("Nanostructured Dielectrics Good Candidates for Next Generation Computer Chips," OE Reports, No. 194, (February, 2000) pp. 1 – 3).

Chen et al. do not explicitly disclose that the etch stop layer has a dielectric constant of about 2. However, Bains discloses that IBM produces a porous organosilicate dielectric material of dielectric constant equal to 2.2. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize an organosilicate material with pores to attain a low k etch stop layer for use in forming damascene interconnects, and hence to combine Bains and Chen et al.

18. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. in view of Fink et al., as applied to Claims 1, 5 – 7, 29 – 33, 37, and 38, and further in view of Uglow et al. (US 6,251,770 B1).

19. Regarding Claim 28, Chen et al. disclose a structure comprising an electrically conducting trace (20) (Figure 6B) in the substrate. Chen et al. do not disclose a first and second recess in the ILD layer wherein a first width extends from a bottom surface of the ILD layer up to a position partway through the ILD layer, and a second width wider than the first width and extending from the top of the first recess to the top of the ILD layer. Uglow et al. disclose an ILD layer (106') (Figure 10B) wherein the first recess has a first width and extends to a position partway through the layer, and a second recess with a width wider than the first, extending from the top of the first recess to the top of the ILD layer.
Further, Chen et al. do not disclose a contact disposed in the first and second recesses, where the contact makes electrical connection to the trace. Uglow et al. disclose a contact (302) disposed on the two recesses and making electrical connection to the trace (122). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Uglow et al. with Chen et al. to obtain a damascene structure to interconnect various parts of the circuit.

20. Claim 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. in view of Uglow et al.

21. Regarding Claim 34, Chen et al. disclose a structure wherein the diffusion barrier layer comprises silicon nitride (Col. 6, lines 4 – 7), the etch stop layer comprises an organic polymer (Col. 6, lines 8 – 12,

Chen et al. do not disclose an ILD layer comprising carbon doped oxide. However, Uglow et al. disclose (Figure 10B) that the ILD layer (106') comprises a carbon doped oxide (Col. 6, lines 29 30). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Uglow et al. with Chen et al. to obtain reduced inter-metal capacitance and faster devices (Uglow et al, Col. 1, lines 29 – 31).

Chen et al. disclose that the ILD layer has a third thickness and as discussed for Claims 32 and 38, that the second thickness (5000 Angstroms) is at least 10 times as thick as the first thickness (500 Angstroms). Chen et al. do not disclose that the third thickness is at least 5 times as thick as the second thickness. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to perform a series of experiments to obtain a third layer thickness in the recited range of the instant application to reduce parasitic capacitance.

Claim Rejections – 35 U.S.C. 102

22. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

23. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being anticipated by Uglow et al. (US 6,251,770 B1).

24. Regarding Claims 9 and 10, Uglow et al. disclose (Col. 4, lines24 – 25) an electrically conductive trace (122) (Figure 2) in a substrate and coplanar with the upper surface, with a structure on the substrate comprising a inorganic (silicon nitride) diffusion barrier layer (102) (Figure 2) above and on substrate and trace, with an inorganic (silicon dioxide) layer used as an etch stop layer (Col. 4, lines 50 – 53) (104) above and on the diffusion barrier layer and an (inorganic) ILD layer (silicon dioxide) disposed above and on the etch stop layer, with the diffusion barrier layer and etch stop layer mutually selected from an inorganic composition.

Uglow et al. do not explicitly disclose that the thickness of the diffusion barrier layer is 500 Angstroms. However, Uglow et al. do disclose that the total thickness of the dielectric layers is about 10,000 Angstroms (Col. 6, lines 62 – 63). Since the thickness of the second (104) layer is 4500 Angstroms (Col. 4, line 50) and the thickness of the third (106) layer is 5000 Angstroms, the thickness of the first (barrier) layer is then 500 Angstroms. It is therefore implicit that the thickness of the diffusion barrier layer is in the range, one monolayer to 1000

Angstroms.

25. Claims 16 –18 are rejected under 35 U.S.C.102(e) as being anticipated by Chen et al.

26. Regarding Claims 16 – 18, Chen et al. disclose (Col. 5, line 65 through Col. 6, line 22) a structure on the substrate comprising an inorganic (silicon nitride) first dielectric layer (24) (Figures 4 and 6B) above and on substrate and trace, having a thickness in the range, 300 to 500 Angstroms, with an organic (arylene ether polymer) (FLARE) layer used as an etch stop layer (See Figure 4)
above and on the first dielectric layer and an interlayer dielectric (ILD) disposed on the etch stop layer wherein, a conductive damascene "plug" is present (Col. 8, lines 1 and 2) in recess 45 (Figure 6B), where the conductive layer is in contact with first dielectric layer, etch stop layer, and ILD layer.

Response to Arguments

27. Applicant's arguments with respect to claims have been considered but these have been found to be unpersuasive. In particular, Applicant has repeated some of the arguments presented in the previous Office Action. Since these have been addressed in detail, only a summary will be given herein. Applicant contends throughout the Response (pp. 9 – 10) that layer 34 is not an ILD layer and layer 30 is not an etch stop layer. Examiner does not concur. layer 34 is a dielectric and can be disclosed as an ILD layer, as would be recognized by one of ordinary skill in the art. Although Applicant has argued on the basis of etch rate differences,

there are no recitations in the claims of such etch rate differences. However, due to chemical differences between the organic and inorganic dielectric layers, the plasma etch rate of the organic dielectric is significantly less than that of the inorganic, as is well known in the art (Wang et al., US 20040207091, para. [0112]), contrary to allegations of Applicant. Further, in the reference (Col. 6, lines 9 – 15) the etch stop is organic and the overlying dielectric is SiO2.

Regarding Claim 8, Examiner has eliminated the case law reference. An additional reference has been added.

In regard to the allegation that the effective dielectric constant is greater than 3.0 (p. 11, Response) Examiner does not agree. For layer 24 the thickness is in the range, 300 to 500 Angstroms (Col. 6, lines 6 – 7), for layer 30, thickness is in the range, 1600 to 7000 Angstroms (Col. 6, lines 10 – 11), and for layer 34, the thickness is in the range, 1000 to 3000 Angstroms (Col. 6, lines 16 – 17), wherein k1 = 7.9, k2 in range, 1.1 to 1.5 (porous) (M. Clarke, Mykrolis Applications Notes, p. 5) and k3 = 3.9. Therefore, when the thickness of layer 34 is increased to a value about 5 times that of the second layer, using the formula presented in the rejection for Claim 1, k(eff) is approximately 42500/[500/7.9 + 7000/1.1 + 35000/3.9] Examiner calculates a range of values for the thicknesses disclosed, wherein, k(effective) is less than about three.

With regard to Claim 28 (p. 12, Response), Examiner does not agree with the contention of Applicant that the two references cannot be combined. Chen et al. do not explicitly disclose a

contact "*disposed in the first and second recesses, wherein the contact makes an electrical connection to the trace.*". There is certainly a rationale for combining, since Chen et al. do not disclose a "filler" layer within the recess. Further, contrary to the allegations of Applicant, layer 106 does indeed provide the patterning functionality and is used to form a trench (Figure 6) and via. Therefore, the two references can be combined.

The references given in this section represent support for Examiner's response to arguments of Applicant.

Conclusions

28. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to **Thomas Magee**, whose telephone number is **(571) 272 1658.** The Examiner can normally be reached on Monday through Friday from 8:30AM to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the examiner's acting supervisor, **Stephen Loke**, can be reached on **(571) 272-1657.** The fax number for the organization where this application or proceeding is assigned is **(703) 872-9306.**

Thomas Magee
June 6, 2005

Steven Loke
Primary Examiner
Steven Loke